

**Syphilis Interventions Toward Elimination (SITE) model
– Country data required for a national program scenario analysis**

*Version 09 July 2020*  

**1. Introduction**

*Syphilis Interventions Toward Elimination (SITE)* is a mathematical model that evaluates and projects the epidemiological impact, cost and cost-effectiveness of syphilis treatment, prevention and screening interventions to control and eliminate syphilis transmission in a national adult population.

The model is still under development and will be piloted in July 2020 with the governments and WHO country offices of Papua New Guinea and Peru.

This note details the country data required to calibrate the model to a national epidemic, reflecting past and current control program efforts, as a basis for scenario projections to inform national control strategic planning and health impact goals and intervention service delivery targets for syphilis.

The note does not cover sources and data for the model’s biomedical parameters, which are not specific to any country but rather global or regional. The model’s biomedical parameters are pre-filled with estimates based on global literature reviews and meta-analyses [[1](#_ENREF_1)].

The SITE model estimates the transmission and control of syphilis in an adult population. The model distinguishes 7 risk groups who acquire and transmit the infection depending on their sexual behaviour:

Low-risk Women, Low-risk Men, Medium-risk Women, Medium risk Men, High-risk Women i.e. Female Sex Workers (FSW), High-risk i.e. clients of FSW, and Men who have Sex with Men (MSM).

Besides these 7 groups the population modelled includes two additional groups:

* Not Sexually Active Women
* Not Sexually Active Men,

for whom syphilis incidence and prevalence by definition is 0, and for whom no input data are required other than their group size.

The 7 sexually active groups interact in 4 types of partnerships:

* Low-risk i.e. stable or marital relationships
* Medium-risk relationships i.e. casual heterosexual relationships
* High-risk heterosexual contacts i.e. between a FSW and her client
* MSM contacts.

**Time period for data compilation**

The SITE model starts every projection in 1970. Since untreated syphilis has a long duration, a long historic ‘warm-up’ period is needed for the model to reach epidemic equilibrium by the time that users want to start scenario analysis (e.g. 2020).

For calibration graphs and checks, *prevalence data* are relevant and can be entered for any year from 1970 onwards, as available – see Section 2 below. Clearly it is most important to have some data for each population group over recent years, e.g. 2015-2020. In the 2020 model version, the check on epidemic calibration/fit is left to the user to do visually, by combining their prevalence data inventory with the model output file. The only prevalence that enters the model as a required input is the initial prevalence at 1970. Prevalence data are often scarce or absent pre-2000, in which case for 1970 the prevalence should be set in line with the oldest data point available for each group, and/or taking into account the apparent trend (decline/stable/increase) in prevalence over the first years with data.

All *population sizes, behavioural parameters and intervention coverages* need to be entered for each and all years over 1970-2050 – see Section 3 below. But such data are typically available only for a subset of those years (e.g. years with a survey). The parameter values for years in between are typically filled by interpolation e.g. drawing a line (linear interpolation) between 2 successive surveys.

**2. Syphilis prevalence data**

The model is calibrated to a national epidemic, fitting its results for the prevalence of syphilis in each of these 7 groups. To this end, users can compile prevalence data in an Excel table. The more data the better, for any years from 1970 to today, and ideally covering a wide range of populations and samples.

The same Excel table can subsequently be used to plot graphically the fit of the model projection against those data.

Table 1 summarize the typical sources of syphilis prevalence data, and how they map to population groups in the SITE model.

Table 2 summarizes the data elements to extract for each data point.

**Table 1. Types and sources of syphilis prevalence data**

| **Population group(s)** | **Data source** |
| --- | --- |
| Pregnant and other Low- and Medium-risk women\* | * Antenatal Care (ANC) sentinel surveys
* Routine programmatic screening of women attending ANC
 |
| Low-risk and Medium-risk men and women\*\* | * Blood donor screening, from blood banks
* Demographic and Health Surveys (DHS)
* AIDS Indicator Surveys (AIS)
* Population-based HIV Impact Assessment (PHIA)
* Other representative sample sero-surveys, among communities/households, Family Planning clinic attendees, students, workers, military (recruits)
 |
| High-risk women i.e. FSW, and MSM\* | * Integrated Bio-Behavioural Surveys
* Second-generation Sentinel Surveillance
* Other surveys/ studies
 |
| High-risk men i.e. FSW clients | * Surveys among STI clinic patients, military/military recruits
* Household/community surveys in the preceding row, if these also include self-reports about paying for sex
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\* While these are 2 different in the SITE model, these groups are combined in this table, according to their representation in typical data sources listed in the 2nd column.

\*\* While these are 4 different in the SITE model, these groups are combined in this table, according to their representation in typical data sources listed in the 2nd column.

**Table 2. Data elements to extract for each prevalence data point**

|  |
| --- |
| * Sample size tested for syphilis
* Number of people test-positive i.e. infected with syphilis
* Diagnostic test used
* Calendar year(s) of data collection
* Population type sampled (see Table 1)
* Optionally (for context): Location, for example [capital city name] or ‘2 rural villages’ or ‘urban’ or ‘rural’
* Official reference of the data source: Authors, title, publication date & location, report number, URL if available.
 |

Each data point is adjusted in the model to reflect the diagnostic test type. Test type adjustors are based on those used in Spectrum-STI burden trend estimations and the WHO’s global syphilis estimations – detailed in [[2-4](#_ENREF_2)].

**3. Sexual behaviours and risk population group sizes**

To simulate syphilis transmission in a population, the model requires

1. The size of each of the 7 risk groups, as well as for the two not sexually active groups (so a total of 9 groups), typically from the following sources:
* Not sexually active women and men: self-reports from national household surveys like a DHS.
* High-risk men i.e. FSW clients: self-reported paying for sex (e.g. in the last year), from DHS, other representative community/household surveys.
* FSW & MSM: IBBS and sentinel HIV/STI sample surveys & surveillance, or size estimations done in the context of HIV estimates, e.g. application of the Spectrum-AIM/EPP or Goals model [[5](#_ENREF_5)]\* or the AIDS Epidemic Model AEM [[6](#_ENREF_6)], or, if country data lack, regional UNAIDS size estimates [[7](#_ENREF_7)]
* Low- & Medium-risk Women, and Low- & Medium-risk Men combined: By definitions, this is the total national female or male population [[8](#_ENREF_8)], minus the sizes of the other female or male groups listed in the preceding 3 bullets.
* Split between Low-risk and Medium-risk: based on self-reported numbers of partners in the last year, from DHS or other representative surveys.

B. Sexual behaviours in each of the 7 risk groups. This includes:

* Proportion of each group that is married, i.e. who have a heterosexual relationship with a low-risk woman or man.
* Number of sexual partners, as average per year.

Note: in the model it is assumed that all Low-risk women and Low-risk men are married and that they have 1.0 partners per year.

C. For each of the four types of partnerships in the model:

* Number of sexual contacts per partnership per year;
* Proportion of contacts where a condom is used.

For Low- and Medium-risk men and women, as well as for High-risk men i.e. FSW clients, all 4 parameters under B and C are typically informed by self-reported behaviours in DHS and other representative community/ household surveys. For FSW and MSM, these behavioural characteristics are typically measured in IBBS or HIV/STI sentinel surveys.

D. For FSW, the average duration of the career of being a FSW (in years). This can be informed from any of the following data, which are measured in IBBS or sentinel surveys, and converted into a career duration estimate according to [[9](#_ENREF_9)]:

* the time a woman spent being an FSW until death or cessation of sex work;
* % of a sample of FSW who report having started being a FSW within the past year;
* mean or median duration of being an FSW, from a representative sample.

If some of these data are not available for a country, then the model can be calibrated using data from a neighbouring country or another country with similar socio-demographic and health-related characteristics. Also, for 63 low- and middle-income countries Avenir Health has available up-to-date model representations of the national HIV epidemic (in the Spectrum-Goals model [[5](#_ENREF_5)], which uses a similar risk groups structure), which can serve as starting point for most behavioural and population size (and FSW duration) parameters also used by the SITE model.

**4. Program and intervention service coverage**

The model allows the user to explore several health care interventions for syphilis, including screening followed by treatment, clinic-based symptom-driven treatment, and contact tracing of index patients treated clinically. The model requires the user to specify past and current coverage for each intervention, separately for each of the 7 risk groups. Table 3 lists data sources that users can consult to inform these parameters.

The historic coverage (1970-2020) can then be used to set relevant targets for future years (2021-2050) to explore in the model scenarios.

For syphilis screening, the model requires coverage to be specified, in each of the 7 risk groups, for two diagnostic test algorithms:

* RPR (with or without TPHA)
* TPHA alone (i.e. no RPR test).

This distinction is required because the ‘TPHA alone’ algorithm will pick up individuals cured from syphilis but still TPHA-positive (Compartment 6 of the model’s natural history flow chart), but who in a test-and-treat protocol will still be treated, which has repercussions for costing and cost-effectiveness of the screening scenario.

**Table 3. Types and sources for data on syphilis program intervention/service coverage**

| **Intervention** | **Data type** | **Source** |
| --- | --- | --- |
| Clinical syphilis treatment of symptomatic Primary/Secondary phase cases | Routine case reports of Primary & secondary phase cases treated – ideally by clinical stage, sex and for women separately for ANC and non-pregnant women. If no data, defer to a default/regional estimate, e.g. from WHO global STI estimates, for countries/regions with low/medium or good STI treatment access [[2](#_ENREF_2)] | HMIS & DHIS-2Annual HIV/STI program reports – ideally covering not only public but also private services |
| Syphilis screening & treatment: ANC | Product of 3 service coverage indicators:* % of pregnant women who attend ANC at least once
* % of pregnant women at 1st  (or any) ANC visit screened
* % of women found positive on screening who got adequately treated.
 | ANC attendance: DHS, MICS or other representative community survey.Screening & treatment: Routine program reports, or ANC sample surveys |
| Contact tracing after index patients treated clinically for symptomatic primary/secondary s | * Number of contacts traced,
* Yield/prevalence of syphilis cases (by stage) among contacts traced.
 | Routine program reports |
| Screening & treatment: FSW & MSM | IBBS or sentinel surveys: if these don’t report specifically on syphilis screening coverage, this may be approximated by the coverage of outreach (e.g. in last 12 months) with HIV prevention and/or HIV testing – as also articulated and used in HIV impact models like Spectrum Goals [[5](#_ENREF_5)] or the AIDS Epidemic Model AEM.  |
| Screening & treatment: men | Typically little data available. Can set to low or 0 if no evidence of any active screening services beyond ANC and key populations. | If applicable: Routine program reports |

**4. Program service delivery unit costs**

For all interventions detailed in Table 3, as well as for condom distribution and promotion, the user can specify a service delivery unit cost. Unit costs are not required for running epidemic projections but are needed to calculate program cost and cost-effectiveness. For this reason, the behavioural and intervention coverage parameters listed in Tables 2 and 3 are specified in the input file whereas the unit costs are specified in the output file.

**Further information**

This document complements:

* Syphilis Interventions Towards Elimination (SITE) Model – User guide to the R-code user interface, by Korenromp-EL, Rowley-J and Mahiané-GM, June 2020.
* The Syphilis Interventions towards Elimination (SITE) model to inform national strategies and targets for syphilis control – technical methods report, by Korenromp-EL, Mahiané-GM, Glaubius-R & Stover-J, June 2020.
* Syphilis Interventions Towards Elimination (SITE) Model Training Exercises, by Korenromp-EL & Rowley-J, June 2020.

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**References**

1. Korenromp EL, Mahiané G, Glaubius R, Stover J: **The Syphilis Interventions towards Elimination (SITE) model to inform national strategies and targets for syphilis control – technical methods report**. In*.* Geneva / Glastonbury; 2020.

2. Newman L, Rowley J, VanderHoorn S, Wijesooriya NS, Unemo M, Stevens G, Kiarie J, Temmerman M: **Global estimates of the prevalence and incidence of four curable sexually transmitted infections in 2012 based on systematic review and global reporting**. *PLoS One* 2015, **10**(12):e0143304.

3. **Spectrum-STI model estimating national STI rates: country surveillance data inputs / Guide to Country data needed to inform a national STI estimation** [<https://spectrummodel.zendesk.com/hc/en-us/articles/115008306167-Application-of-the-Spectrum-STI-estimation-model-estimating-STI-prevalence-and-time-trends-Collating-Country-Data->]

4. **Spectrum STI module -- Manual** [<https://spectrummodel.zendesk.com/hc/en-us/articles/115001964191-Spectrum-STI-Module-Overview-Manual>]

5. Avenir Health: **Goals manual: a model for estimating the effects of interventions and resource allocation on HIV infections and deaths**. In*.* Glastonbury, CT; 2011.

6. Brown T, Peerapatanapokin W: **The Asian Epidemic Model: a process model for exploring HIV policy and programme alternatives in Asia**. *Sex Transm Infect* 2004, **80 Suppl 1**:i19-24.

7. UNAIDS: **Quick Start Guide for Spectrum 2018**. In*.* Geneva; 2018.

8. United Nations Population Division: **World Population Prospects 2019**. In*.*; 2019.

9. Fazito E, Cuchi P, Mahy M, Brown T: **Analysis of duration of risk behaviour for key populations: a literature review**. *Sex Transm Infect* 2012, **88 Suppl 2**:i24-32.